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ANALYSIS OF THE THREE MAIN CONTAINMENT AREAS AT THE BUNKER HILL SUPERFUND SITE

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December 15, 1998

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EXECUTIVE SUMMARY

The Bunker Hill Superfund site cleanup is based, in large measure, on the use of three containment areas where enormous volumes of buried wastes have been placed. Perhaps the most important technical issue regarding cleanup quality and longer term problems is whether the caps over these containment areas are of sufficient quality to absolutely minimize water infiltration. Otherwise, substantial water infiltration and leachate production is likely to cause hazardous waste contaminants to enter the environment. At issue is whether the caps have been required by EPA to have the usually specified capability to greatly restrict water infiltration into the buried wastes.

In one of the three cases, the Smelter Complex containment area, the 1992 Record of Decision did specify the performance standard usually used for hazardous waste landfills and containment facilities at Superfund sites. However, at the other two Bunker Hill containment areas this numerical value for the hydraulic conductivity was not specified. In one case, a conductivity some ten times greater was specified, which means that relatively large amounts of water can infiltrate the Central Impoundment Area causing large amounts of contaminated leachate to form and possibly escape into the environment. For the Page Pond containment area, EPA did not specify any hydraulic conductivity value and it is probable that substantial amounts of water will infiltrate the buried wastes.

Studies done as part of the Feasibility Study showed that most likely about 20% or more of the total annual precipitation would infiltrate the cap of the Central Impoundment Area, and for the Page Pond containment area some 50% or more of the total precipitation would infiltrate the buried wastes. In contrast, for the Smelter Complex containment area, where EPA specified the normally used engineering requirement, only about 3% of the precipitation was estimated to infiltrate the cap, but whether this requirement was met in design and construction requires examination of documents not yet received from EPA.

The less stringent nature of the caps for two of the containment areas reduced the cost of the Bunker Hill cleanup. If EPA was to seriously consider upgrading the quality of the Bunker Hill cleanup, it could consider upgrading the caps for the Central Impoundment Area and Page Pond containment areas to meet the normally used hydraulic conductivity standard that was used for the Smelter Complex containment area. This type of engineering improvement is within the realm of reason, in contrast, for example, to suggesting digging up buried waste in order to construct a standard double lined hazardous waste landfill.

CIA replicates Smelter closure perm. req't per design

INTRODUCTION

Background

The 1992 Record of Decision described three main containment areas and the caps or covers to be used on them. The three containment areas are: the Central Impoundment Area (CIA), the Page Pond area, and the Smelter Complex and Mine Operations Area. One purpose of this report is to better inform concerned citizens about the nature of the containment strategy for the Bunker Hill cleanup.

The ROD specified the use of a "low permeability cap" for the CIA and said that: "The remedial actions proposed for the CIA focus on minimizing releases from this source by installation of a cap designed to minimize infiltration through jig tailings and Central Treatment Plant sludges disposed of in this area. The CIA will also serve as a repository for consolidation of jig tailings/alluvium, gypsum and slag removed as a component of other remedial actions. The cap will be designed to have a hydraulic conductivity of less than 10^{-6} cm/sec. After grading of the CIA surface and dikes to promote runoff, the cap will be composed of a minimum of twelve inches of low permeability material overlain by a minimum of six inches of clean soil suitable for revegetation" [1,2] Hydraulic conductivity refers to the ability of a material to allow water to move through it; the smaller the numerical figure, the lower the conductivity (or permeability). The lower the conductivity, the HIGHER the performance of the cap material. In other words, it is more desirable to have a lower conductivity to increase the containment effectiveness of a cap, which means a greater ability to keep water out of the buried wastes.

It should be noted that using the language of "less than 10^{-6} cm/sec" is not particularly precise, nor is it normal technical language. It essentially means that the conductivity must be less than 1×10^{-6}; that is, the number multiplying 10^{-6} must be less than one. If the conductivity was specified as 10^{-7} than that would be equal to $.1 \times 10^{-6}$. In other words, because EPA did not specify either 10^{-6} or 10^{-7}, the conductivity of the cap was required to be within range of 10^{-6} to 10^{-7} cm/sec. In practice, it would be likely that testing of the cap materials would produce conductivity values with an average value just slightly less than 1×10^{-6}, because it would be cheaper to do so. In the following discussions, for simplicity, it will be assumed that the CIA cap would have a conductivity of 10^{-6} cm/sec. By allowing any value less than 1×10^{-6}, EPA provided a way to spend less money on the cap for the CIA.

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[1]The common notation of 10^{-6} means $1/10^{6}$ or 1/ 1 million, or one millionth. A number 10 times larger is 10^{-5} and a number 10 times smaller is 10^{-7}.

[2]Note that the April 1998 Explanation of Significant Differences by EPA documented that wastes from other areas of the CdA Basin could be disposed in the CIA. This contradicted the EPA position expressed in the September 1996 ROD Amendment which said that no such offsite wastes would be disposed at Bunker Hill.

For the Page Pond area, the ROD said that the cleanup would "Cap Page Pond benches with residential soils" and that "The regrading and capping of Page Tailings Impoundment with residential soils will serve as a barrier to direct contact with tailings within this impoundment and will facilitate revegetation efforts in that area. In addition, the cap will decrease the leachate generation of the Page Pond area by promoting runoff and evapotranspiration compared to current conditions."

For the Smelter Complex, the ROD said that the cleanup would "Cap Lead Smelter and Zinc Plant with low permeability cap." EPA's December 1995 Explanation of Significant Differences combined the Lead and Zinc Plant Closure areas into one containment area, the Lead Smelter containment area, and the Phosphoric Acid/Fertilizer Plant materials were also combined into the Lead Smelter area.[3] The ROD specified that the "Closure of the Lead Smelter and Zinc Plant will consist of a minimum of one foot of low permeability material or a soil/geosynthetic cap (or an appropriate combination of the two) that will have an in place hydraulic conductivity of less than or equal to 10^{-7} cm/sec to minimize water infiltration and subsequent contaminant migration."[4] **It is very important to note that this numerical requirement for the hydraulic conductivity of the cap is 10 times smaller than that specified for the CIA, which means that much less water infiltration through the buried waste is allowed for the Smelter Complex cap than for the CIA. Also note that no such numerical requirement was specified for the Page Pond area.**

It is necessary to note that the September 1996 Amendment to the ROD by EPA replaced treatment of the Principal Threat Materials with containment in a plastic lined "monocell" that would be "covered with a HDPE cap, which will cover the entire Smelter Complex Closure Area. This top liner will provide a supplemental barrier to infiltration." In other words, the use of the plastic liner would help achieve a low hydraulic conductivity. Such plastic liners are normally used in low permeability cap or cover systems for hazardous waste landfills and containment facilities. EPA noted that the size of the monocell was about 3 acres, compared to a total area of 30 acres for the Smelter Complex Closure Area. The Amendment did not change the performance requirement of 10^{-7} cm/sec for the permeability of the overall Smelter Complex cap. The Amendment specified a 3-ply, reinforced copolymer laminate geomembrane (plastic) cover, and a minimum of 12 inches of soil placed over the plastic.

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[3]Note that the December 1995 Explanation of Significant Differences documented that a portion of the A-1 gypsum pond pile waste originally planned for disposal in the CIA would be placed in the Lead Smelter containment area.

[4]Note that the original 1992 ROD called for a cover on some existing solid waste landfills in this area, but that the April 1998 Explanation of Significant Differences by EPA documented that the landfills were excavated instead and the wastes placed into the CIA and Smelter Closure containment areas.

Scope of this report

The main purpose of this analysis is to review the cap requirements or specifications for the three main containment areas relative to more typical cleanup requirements for Superfund sites, and to assess the potential for problems in the future related to low quality performance of the caps. The principal technical issue is whether the Bunker Hill containment facilities have caps that truly minimize water infiltration and the generation of contaminated leachate. It should also be noted that caps are often called covers, but that soil covers usually are much more permeable than caps; that is, soil covers allow much more water infiltration than engineered caps.

In addition to the 1992 ROD, the Feasibility Study and the Remedial Investigation report for the non-populated areas, there were three other key documents, prepared as detailed supplements to the FS, reviewed for this analysis; they were: RI/FS Technical Memorandum: Evaluation of Proposed CIA and Page Pond Closure (May 1, 1992); RI/FS Technical Memorandum: Evaluation of Proposed Smelter Complex Closure Methods (May 1, 1992); and RI/FS Technical Memorandum: Post-Remediation Water-Quality Projections for Feasibility Study Alternatives 2,3, and 4 (May 1, 1992). All of these documents were prepared by a contractor working for the mining companies. However, it should be noted that no design documents have been received from EPA or found in the local repository, and that such documents might have important relevant information concerning this analysis. It must be emphasized that there a many technical factors regarding design and construction of caps that influence cap quality, particularly over the long term. Many well known problems can arise which cause the actual hydraulic conductivity of a cap in the field to greatly increase because of various kinds of defects either introduced during construction or arising after construction. Caps require long term monitoring and maintenance to ensure optimum performance. Repair and reconstruction of caps are definite possibilities, but much depends on the quality of the long term operation and maintenance program for a cleanup. The loss of containment integrity and performance over time is one reason why statutorily required five-year reviews for Superfund sites are important. Some such reviews have discovered major problems with caps.

- or requested from EPA

TYPICAL SUPERFUND CLEANUP REQUIREMENTS

One of the more interesting aspects of the Bunker Hill cleanup is that EPA has generally not referred to the major containment facilities or areas as landfills, but rather called them containment areas or impoundments. One reason for doing so is to help avoid meeting the more normal requirements for waste landfills under the federal Resource Conservation and Recovery Act (RCRA) regulatory program covering solid and hazardous wastes. For the most part, the word "impoundment" referred to places where liquid wastes have been disposed. The Environmental Glossary defines impoundment as "A body of water confined by a dam, dike, floodgate, or other barrier." This book says that this definition is from EPA documents. Modern landfills have several essential engineered components, including a bottom liner system, a leachate collection system, and a multilayer engineered cap. The Bunker Hill containment areas do not have all these systems. The main environmental concern for all landfills or containment areas is the potential for hazardous contaminants to leach from the buried wastes because of water infiltration and escape into the environment through transport of leachate into the ground and possibly ground and surface waters near the buried waste area.

Focusing on the cap, a key component of EPA's recommended hazardous waste landfill cover system is: "A Low Hydraulic Conductivity Geomembrane/Soil Layer. A 60-cm (24 in.) Layer of compacted natural or amended soil with a hydraulic conductivity of 1×10^{-7} cm/sec in intimate contact with a minimum of 0.5-mm (20-mil) geomembrane liner."[5] This barrier layer is closest to the buried waste, and above it is a drainage one foot layer of high permeability soil or other material, and above this layer is a two feet thick top vegetation soil layer.

Even setting aside the fact that EPA has maintained that the Bunker Hill wastes buried at the site are not officially designated hazardous wastes, and that the containment facilities are not what EPA defines as hazardous waste landfills, for which there is a complex multilayer cap requirement, there is still strong evidence that a cap or cover for any type of waste containment facility is normally required to have high performance capabilities to keep water out of the buried waste, which means a low conductivity. Consider, for example, a recent remedy selection by EPA Region 6 for the Brio Refining Superfund site, Houston, Texas, which also did not use the word landfill, but only described the remedy in terms of "containment."[6] Part of the required remedy was a cover which had to consist of the following: "The cap system (clay cover plus liner) shall achieve a hydraulic conductivity of 10^{-7} cm/sec." The liner refers to a plastic material; the use of a plastic liner or geomembrane greatly assists obtaining a low hydraulic conductivity. Similarly, the seven layer RCRA cap for the landfill or containment area at the Agrico Chemical site, Pensacola, Florida, also had a performance standard of a 10^{-7} cm/sec permeability.[7]

A book on containment technologies used at cleanup sites noted that: "Historically, a compacted clay liner with a thickness of approximately 2 ft and a design hydraulic conductivity of no more than 1×10^{-7} cm/s has been the design standard for landfill caps."[8] In speaking of the low permeability barrier layer of a cap this reference book said: "The barrier layer is often viewed as the most critical engineered component of the final cap. The barrier layer minimizes percolation of water through the cap by impeding infiltration through it and by promoting storage or drainage of water in the overlying layers. If the system is working properly, all or nearly all of the water that infiltrates into the cover system is removed by evapotranspiration or internal drainage."

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[5]EPA, Design and Construction of RCRA/CERCLA Final Covers, May 1991.

[6]July 1997 Amendment to ROD by EPA Region 6.

[7]September 1992 ROD by EPA Region 4.

[8]"Barrier Containment Technologies for Environmental Remediation Applications," R.R. Rumer and M.E. Ryan, editors, John Wiley, 1995.

Another reference book said: "The EPA has for years stated a requirement that compacted-soil liners have hydraulic conductivities of 1×10^{-7} cm/s or less."[9] Virtually every book on the subject of landfills and containment refers to a normal government requirement or performance standard of 10^{-7} cm/sec permeability for caps or covers.

What is evident is that for Bunker Hill, only the Smelter Complex containment area had a specification that can be fairly considered appropriate and consistent with other generally used standards for Superfund cleanups, because of the specification of the 10^{-7} cm/sec hydraulic conductivity. But no such stringent requirement was imposed for the CIA or the Page Pond containment areas. For the CIA, the specification that the hydraulic conductivity be less than 10^{-6} cm/sec creates a major opportunity for having a much more permeable cap allowing greater water infiltration and potential for contaminated leachate generation. The mining companies have no reason or incentive to spend more money to achieve the lowest possible hydraulic conductivity. For the Page Pond area. the mere specification of a low permeability soil cover imposes no stringent performance standard.

Moreover, for the Bunker Hill Cleanup, the absence of leachate collection systems and the absence of active pumping of groundwater in the vicinity of the containment areas mean that there is a serious potential problem. The use of what EPA calls an innovative constructed wetlands approach to groundwater cleanup, which is largely an unproven and speculative low cost approach, greatly increases the possibility that contaminated leachates could reach the CdA river. Nor will the groundwater monitoring system necessarily detect all such leachate discharges in a timely and complete manner. In other words, **the best safeguard against hazardous contaminants in buried wastes becoming mobilized and a new threat to the environment is to have a high quality cap or cover, which means one that has a very low hydraulic conductivity or permeability that absolutely minimizes the amount of water entering the buried wastes. This is more of a prevention approach to environmental protection. For the Bunker Hill cleanup, the main issue is whether the CIA and Page Pond containment areas have low quality caps that greatly increase the probability of longer term releases of hazardous materials into the environment, which may or may not be effectively addressed by planned activities for the site.**

Finally, it is instructive to note some things that EPA's Superfund program itself has said about the use of containment for the cleanup of soils contaminated with heavy metals.[10] Here are the disadvantages of containment according to EPA:

- "design life is uncertain"

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[9] "Soil Liners," in Standard Handbook of Hazardous Waste Treatment and Disposal, H.M. Freeman, editor, Mc-Graw Hill, 1989.

[10] "EPA, Engineering Bulletin: Technology Alternatives for the Remediation of Soils Contaminated with As, Cd, Cr, Hg, and Pb," August 1997.

- "contamination remains onsite, available to migrate should containment fail"
- "long-term inspection, maintenance and monitoring is required"
- "site must be amenable to effective monitoring"
- "The performance of capping systems, once installed, may be difficult to evaluate."

BUNKER HILL FEASIBILITY STUDY TECHNICAL MEMORANDUM ON CIA AND PAGE POND

Various types of caps were evaluated, particularly with respect to different levels of hydraulic conductivity and their impact on the extent of water infiltration through the cap. What is most important for the CIA analysis is that the normally used hydraulic conductivity value of 10^{-7} cm/sec as well as the high value of 10^{-6} cm/sec were used. For the lower 10^{-7} level, the analysis found that only about 3% of total precipitation would infiltrate the soil/clay cap, but for the higher 10^{-6} level over 20% was predicted.[11]

For the Page Pond closure only a simple soil cover was analyzed and the analysis showed that 50% or more of water infiltration was likely under normal or wet conditions. Without the soil cover, it was revealed in one of the documents that about 60% of water infiltrated the wastes. So clearly, there would be very little benefit from the soil cover with respect to reducing infiltration and leachate production.

A simple soil cover had also been analyzed for the CIA, but was rejected because of the high amount of water infiltration, similar to that estimated for the Page Pond area cover.

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[11] The basis for all of the estimates of water infiltration was the use of a standard EPA model called HELP, which requires various data and assumptions. One important assumption is that a stipulated cap hydraulic conductivity actually exists throughout the cap or cover. In actuality, however, the problem is that caps or covers constructed at sites may have places where the conductivity is much greater than the specification, because of various kinds of defects or imperfections, such as cracks. It is well known that it is necessary to measure the conductivity of relatively large size amounts of an actual cap rather than rely on small laboratory samples so that the influence of high permeability areas is accurately assessed. The lower the specified conductivity the greater the margin of safety for a cap, despite the presence of some defects or imperfections. Use of test pads at sites allows more accurate field measurements; it has been found that such larger size measurements of conductivity are often 1,000 times greater than small laboratory samples.

In the Summary and Conclusions section of the report it was said that: "The reduction of percolation into the [CIA] impoundments is best achieved with a barrier saturated hydraulic conductivity of 1×10^{-7} cm/sec or less." Moreover, an appendix to the report presented EPA comments and the contractor's responses, and the very first EPA comment was this:

> "The Agency has reviewed the HELP model runs for the CIA and agrees with the utilization of 10^{-7} cm/sec hydraulic conductivity of the cap for water quality projections. The HELP model runs indicate that a 10^{-7} cm/sec hydraulic conductivity achieves the substantial reductions in infiltration necessary to satisfy RAOs [Remedial Action Objectives] for surface and ground water."

Similarly, in its comments on the draft Feasibility Study and the presentation on the CIA, given in the Executive Summary of the FS, EPA said: "Replace the term soil/clay cap with the performance standard, a 10^{-7} cm/sec hydraulic conductivity cap."

Nevertheless, that is NOT what the subsequent ROD specified for use. The technical justification for using the higher value of 10^{-6} cm/sec was in the third Technical Memorandum noted above on water quality. This document noted that using this type of cap was expected to reduce water infiltration by about 50% for some parts of the containment area, and about 90% for some other parts. The key argument made was that the metals loading resulting from leachate production would be almost the same for using a cap with 10^{-7} cm/sec conductivity as with using one with 10^{-6} cm/sec conductivity. This author finds this view scientifically implausible. It seems implausible that if there is a substantial increase in water infiltration -- over 20% versus 3% -- that there would be no corresponding increasing in metals loading to the environment. **What seems clear is that EPA backed off of its original position in support of the cap with a 10^{-7} cm/sec conductivity and accepted the arguments of the contractor in support of using a lower cost cap with a higher conductivity.**

On a qualitative level, the contractor report also argued that the wastes in the CIA were low in contaminant concentration, particularly as compared to the wastes in the Smelter Complex containment area.

To examine this position certain parts of the Remedial Investigation Report were reviewed, particularly Table 4-10 on CIA area contaminants and Table 4-17 on the Smelter Complex area contaminants. While there is some truth to the perspective that there were some materials with very high contaminant levels in the Smelter Complex, the subject is very complex. In each containment area there are multiple types of materials, each with very broad ranges of contaminant levels. The variations among materials and within material categories are so large as to make simplistic generalizations of limited value. The more important point to emphasize is that even in CIA wastes there are some materials with extraordinarily high contaminant levels. The RI data is also of limited value because there are no data on the volumes for each category of waste.

Compounding the complexity is that examination of groundwater contaminant levels in the

RI are to some extent the reverse of the data for soil and waste contaminant levels. That is, some of the groundwater contamination appears much worse for the CIA area than for the Smelter Complex area. For example, the highest arsenic level in the CIA groundwater was .275 mg/l compared to .012 mg/l in the Smelter Complex groundwater, and the highest lead contamination in the CIA groundwater was .978 mg/l compared to .48 mg/l in the Smelter Complex. In other words, what is important is not just how much contamination is within the buried waste within containment areas, but how much of that contamination is leachable because of water infiltration. From this perspective the RI data seem to indicate a worse situation for the CIA area, at least for some of the contaminants. As additional proof of this perspective, note that the Executive Summary of the RI report presented the maximum average concentrations for five contaminants in the upper zone groundwater, and that for four of these the locations were associated with the CIA.

The overall point is that even if the Smelter Complex was judged to have the highest level of waste contamination, that would not necessarily remove the need for a similar high performance cap for the CIA area in order to provide a higher, necessary level of environmental protection.

As to the Page Pond containment area, it is also important to note that some of the groundwater contamination data in the RI indicate a significant problem. For example, there was a significant arsenic level of .053 mg/l which is much higher than the maximum level of .012 mg/l for the Smelter Complex area; and the lead level of .398 mg/l is comparable to the value of .48 mg/l for the Smelter Complex area. The highest zinc level, while lower than the highest levels for the CIA and Smelter Complex areas, was still quite significant at 11.7 mg/l. The main point is that even for the Page Pond area which was only to receive a simple soil cover with no prescribed hydraulic conductivity, there was evidence of a significant problem of metals leaching into groundwater. EPA's comments on the draft FS included this one: "The soil cap on Page Pond would reduce the infiltration through the tailings but not control the infiltration." Reduce but not control -- what does this really mean? It certainly suggests that EPA recognized a very limited effectiveness of the simple soil cover. Nevertheless, EPA let the PRPs use what they wanted, a simple soil cover with no specified hydraulic conductivity.

BUNKER HILL FEASIBILITY STUDY TECHNICAL MEMORANDUM ON SMELTER COMPLEX

The analysis found that by using a cap with a hydraulic conductivity of 10^{-7} cm/sec the water infiltration could be reduced to about 3% of total annual precipitation, as compared to more than 20% for a conductivity of 10^{-5} cm/sec. The report concluded that certain remedial alternatives, including the one selected, "will effectively limit percolation into the closure areas provided a low enough saturated hydraulic conductivity is achieved within the barrier layer (e.g., 1×10^{-7} cm/sec)." A most interesting aspect of the study was the premise that it would be possible to use certain onsite materials for constructing the cap, and that this was acknowledged to pose some serious technical challenges. "Additional testing" was acknowledged to be necessary to demonstrate that such a low conductivity cap could be constructed from so-called "borrow" soils. What is important to understand that only by using such onsite soils would it be possible to minimize the cost of constructing such a cap. The contractor admitted that newer technical approach to converting onsite materials into such low conductivity material would be necessary but that "experience is limited with this approach." What is not now clear is how the mining companies and their contractors and the various government agencies ensured that consistently low conductivity material was used in the cap for the Smelter Complex area.

One of the more important discussions in this document was in the appendix where the contractor responded to various EPA comments. EPA noted that and apparently supported the finding of the contractor analysis that "a hydraulic conductivity of 1×10^{-7} cm/sec will be required to adequately reduce leachate production. This value is apparently the maximum value by guidance, also." The last comment clearly referred to what EPA guidance documents consistently refer to for a maximum level of conductivity for caps. EPA then went on to raise very serious and appropriate concerns about the potential for actually achieving the desired level of conductivity in the design and construction of the Bunker Hill remedy. EPA referred to the "unproven technique advocated in the memo." EPA also raised very appropriate concerns about severe weather conditions that are well known to seriously degrade low permeability caps. EPA had correctly addressed dramatic changes in weather and made this comment about the contractor report: "The most challenging weather effects may not have been considered."

Some of the contractor's statements strongly support the view of this author that the actual design and construction of the Smelter Complex cap [and the other caps or covers] requires further examination.[12] The contractor admitted that "The certainty of achieving a hydraulic conductivity of 1×10^{-7} cm/sec is undetermined at this time." The contractor also acknowledged that it would be necessary to have "an active O&M [Operation and Maintenance] program, with specific criteria and procedures, to detect and repair damage to either the cap or the cover layer." Concerned citizens may not fully appreciate just how serious and critically necessary such a very long term inspection and repair program is. Yet as time goes by and public attention declines, there is less and less assurance that there will be effective site monitoring and maintenance over many decades.

It should be clear from the work done on the Smelter Complex containment area cap that there were important economic and technical reasons why the mining companies wanted to avoid using such a low conductivity cap on the CIA and Page Pond containment areas.

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[12]All relevant design and construction documents would be reviewed relative to some very detailed EPA guidance: "Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities." For example, EPA has very definite positions regarding the testing for hydraulic conductivity.

DISCUSSION AND CONCLUSIONS

The conclusion of this report that the specification for the cap on the CIA was not appropriate is consistent with a comment provided to EPA by the U.S. Department of Interior on the Proposed Plan, ultimately adopted as the 1992 Record of Decision. Interior said:

> "The closures using RCRA caps with hydraulic conductivity of 10^{-7} cm/sec (p. 15) is an important requirement and should be required for the CIA (not 10^{-6} to 10^{-7} cm/sec range stated on p. 14)."

Interior referenced the significant different between having water infiltration reduced to about 3% rather than over 20%, the same point made in this report. Interior also said: "We believe that this is an important reduction (especially since the CIA seeps are a 680 lb/day loading source) and that 10^{-7} cm/sec should be required by the plan. We disagree with the PRPs' response in the FS Executive Summary to agency comment (volume II) number 225 on page 28 that the 10^{-7} cap is not appropriate because it is more protective than Idaho normal tailings pile closure requirements. This is a Superfund site along a water quality limited stream segment where more than normal Best Management Practices should be required."

Nevertheless, EPA did NOT change its position, based on what the PRPs wanted.[13] Instead, it provided what it called "mitigating factors that support 10^{-6}." For example, it argued that certain materials would be removed from the CIA and that some tailings would not be placed in that area. Most interestingly, EPA also argued that "there has been extensive community comment in support of maintaining open space or similar uses for the CIA. A 10^{-7} cap would likely require greater restrictions on future use." This position is most fascinating. While it is certainly true that it is not reasonable to think about future land use for a capped landfill whose cap must be carefully monitored and maintained, it is difficult to understand why this would be less so for a cap with a conductivity of 10^{-6}. ANY future use of the CIA area would, to some degree, place in jeopardy maintaining even a 10^{-6} conductivity cap.

The Feasibility Study said the following regarding soil/clay cover systems: "Soil/clay covers are installed using standard earth moving techniques; however, imperfections and differential compaction of the clay can result in regions of greater permeability through which infiltration may occur. Therefore, experienced and skilled contractors are required for implementation of this option. Also, the surface of soil/clay caps must be protected from human

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[13]To its credit, it appears that EPA probably negotiated a somewhat more stringent specification for the CIA cap than the PRPs wanted, as evidenced by the fact that the FS only referred to a low permeability cap for the CIA, while EPA's Proposed Plan and ROD provided the hydraulic conductivity range. But the big benefit for the PRPs was the avoidance of a requirement for a 10^{-7} cm/sec conductivity cap for the CIA, as required for the Smelter Complex cap.

disturbance and surface erosion to prevent damage."[14] This is why examining design and construction actions is very important and why future use of a capped area raises serious issues regarding long term cap effectiveness. It should be understood that more highly engineered and expensive multilayered caps, required for hazardous waste landfills, are more likely to be able to withstand some limited future land uses than a simple, low cost cap.

Lastly, EPA also argued that using a 10^{-7} cap would not, according to the water quality technical memorandum, provide much additional reduction of metals loading, without ever explaining however how a more than 20% infiltration rate would not lead to more of a negative impact as compared to the 3% infiltration rate. The key point is that EPA acknowledged that use of the 10^{-7} cap on the CIA would require "an inordinately greater expense." In other words, as with virtually every major decision and change about the Bunker Hill remedy, cost reduction was a driving force.

It would be most appropriate for EPA to conduct a more thorough and independent analysis of the relative impacts on environmental loading of waste contaminants from using a 10^{-7} versus a 10^{-6} cap on the CIA.

For the 1992 ROD, the Tribe also made various comments that strongly questioned EPA's decisions about the containment areas, including: "Neither the unit referred to as the Smelter Complex cap, nor the one referred to as the CIA cap are adequately designed to ensure that contaminants will not migrate out of the unit." EPA expressed its disagreement with this view. The Tribe repeatedly provided comments arguing that EPA should have complied with various regulatory requirements for hazardous waste landfills or impoundments, but EPA disagreed.

It is concluded that studies done as part of the Feasibility Study showed that most likely about 20% or more of the total annual precipitation would infiltrate the cap of the Central Impoundment Area, and for the Page Pond containment area some 50% or more of the total precipitation would infiltrate the buried wastes. In contrast, for the Smelter Complex containment area, where EPA specified the normally used engineering requirement, only about 3% of the precipitation was estimated to infiltrate the cap, but whether this requirement was met in design and construction requires examination of documents not yet received from EPA.

The less stringent nature of the caps for two of the containment areas reduced the cost of the Bunker Hill cleanup. If EPA was to seriously consider upgrading the quality of the Bunker Hill cleanup, it could consider upgrading the caps for the Central Impoundment Area and Page Pond containment areas to meet the normally used hydraulic conductivity standard that was used for the Smelter Complex containment area. This type of engineering improvement is within the realm of reason, in contrast, for example, to suggesting digging up buried waste in order to construct a standard double lined hazardous waste landfill.

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[14] Appendix C on Remedial Technologies, Feasibility Study Volume III.

It is likely that EPA, in response to the issues raised in this report, will take the position that it does not matter whether high, preventable levels of waste contaminants will leach out of the CIA and Page Pond containment areas. EPA may argue that the constructed wetlands method planned for treating contaminated groundwater from the site to address loadings to the CdA river will handle the problem. However, there is no assurance that the constructed wetlands will in fact reduce metals loadings to the river to a degree sufficient to meet water quality standards. The best strategy for a Superfund cleanup is to prevent leachate formation as much as possible, rather than on relying on some method of groundwater and leachate treatment, especially in this case where a relatively novel but cheap method of dealing with contaminated groundwater is planned